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THE EMERGING INFORMATICS MARKET

- A Discussion Paper -

Communications Division

December 1985



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Telecommunications Industry Development Office
Communications Division
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INTRODUCTION

The purpose of this paper is to increase awareness of the emerging economic opportunities in the informatics market for the Province of Ontario.

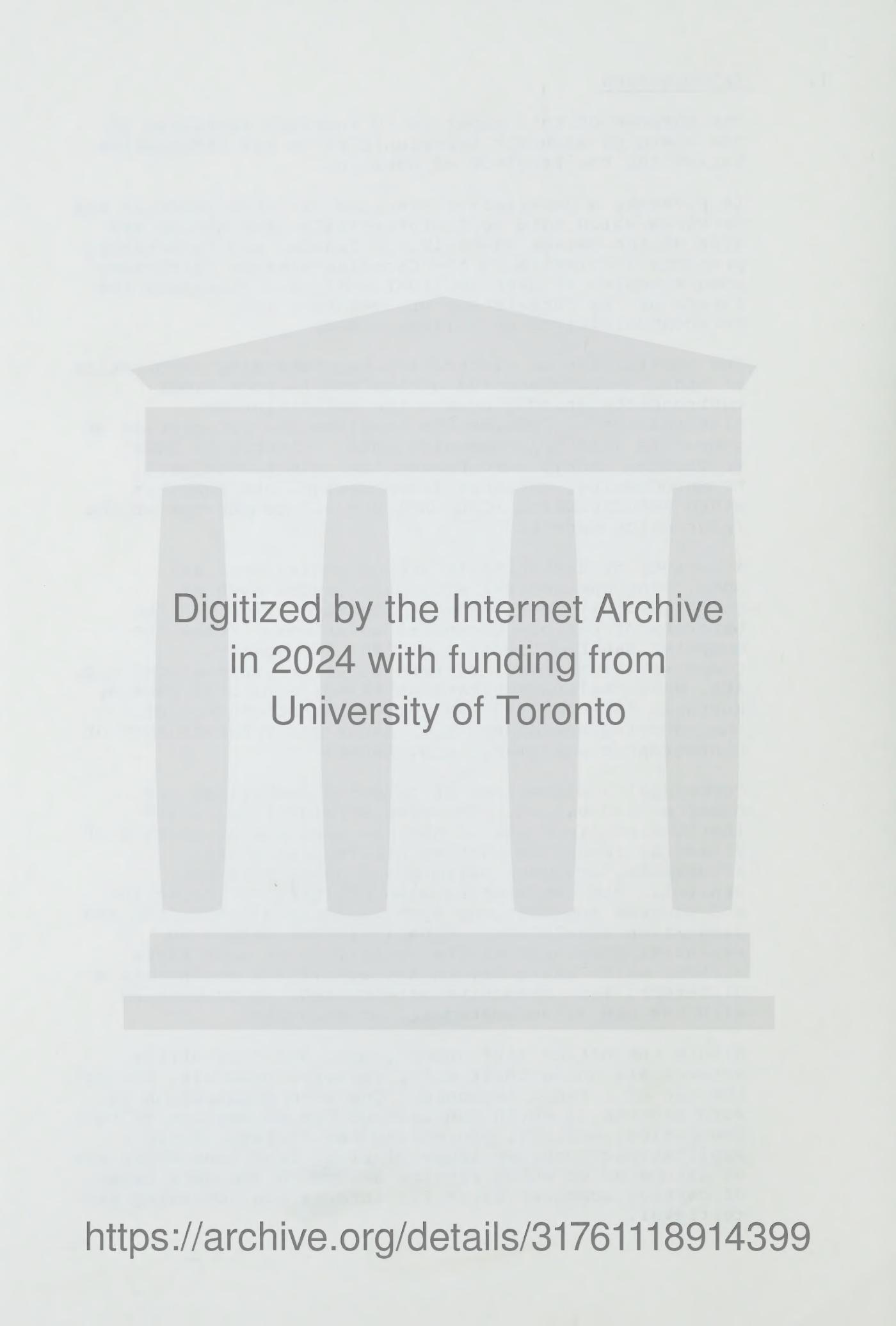
It presents a descriptive overview of: the products and services which make up "informatics"; the nature and size of the market globally, in Canada, and in Ontario; presents statistics on the Canadian market; discusses some examples of user applications; and discusses the future of the integration of computers and telecommunications on a large scale.

The application of electronics to processing information in order to automate the office and factory floor environments broadly covers the definition of "informatics". Informatics involves the integration of computers with telecommunications. Electronic Data Processing (EDP), word processing, electronic mail, teleprocessing, computer aided design, and computer aided manufacturing (CAD/CAM) are all components of the informatics market.

A variety of technologies and companies meet and complement one another with differences such as compatibility, cost, ease of implementation and the benefits of various technical solutions. These are computer manufacturers, e.g. IBM, NCR, Sperry, ComputerVision; manufacturers of office automation, e.g. AES, Wang; telecommunications firms, e.g. Bell Canada, Northern Telecom; and may include manufacturers of photocopying equipment, e.g. Xerox and manufacturers of photographic equipment, e.g. Kodak.

Commercial applications of computer technology are numerous and varied. The most straightforward and institutionalized use of EDP has been the automation of financial functions such as billing, accounts receivable, accounts payable and basic inventory control. The computer is also utilized in production and process applications such as materials planning and production scheduling. Finally it has become an essential component of the operations of some firms without which their day to day activities would take a different, less effective orientation, as in banking with the use of automated teller machines.

Within the office environment, more and more office workers are doing their work, wherever possible, through the use of a video keyboard. One such application is word processing which consists of the automation of text generation, editing, processing and filing. Other applications comprise those clerical functions which can be automated or which require access to the data bases of central computer sites for information accessing and retrieval.



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Where the automation of clerical functions could be carried out more economically and expeditiously at a workstation, with minimal or no assistance from a central computer site, the display terminals are converted to personal computers. In addition, personal computers are purchased by independent businessmen and professionals as stand-alone systems for a variety of business and scientific functions.

By tying the various electronic components of the office environment such as the display terminals, the printers and the storage media into a telecommunications network, it also becomes possible to communicate between these devices inside and outside the office. Word processing and automation of clerical work then also encompass electronic mail. Video terminals in the office environment are for these reasons proliferating.

The integration of these functions in the office environment is often referred to as informatics. This term also implies the integration of computers and telecommunications in the factory environment. Office automation, integrated business systems and integrated office systems are other terms that describe the same assemblage of equipment, software and services. As computers, telecommunications equipment and office equipment continue to complement each other, the average user is faced with a bewildering array of options. This prevailing confusion is, in some cases working against the acceptance of the products of many vendors, and may in some cases be dampening the growth of the market. Nevertheless, the informatics market in Canada is expected to grow from \$4.6 billion in 1984, to \$13 billion by 1993.

2.

MARKET SEGMENTATION

The informatics market may be subdivided into the following submarkets: the computer and telecom equipment market, the office equipment market, microcomputers and the factory automation market, and the software market.

a) Computer and Telecom Equipment Market

The computer equipment market consists of manufacturers of computers, peripherals, data communications equipment and user-level devices.

The peripheral category covers equipment attached to a computer that would generally be found in a data processing environment. It includes such items as disc drives, tape drives, computer microfilm equipment, high speed printers and optical character readers.

The telecom or data communications category covers equipment that is associated with the integration of computers and telecommunications networks. It includes analog modems and acoustic couplers, limited distance data sets (including line drivers), front-ends for telecommunications processing, multiplexors, concentrators and computer switching equipment.

The user-level device category covers devices that often interface with the user. It includes equipment such as point-of-sale terminals, banking terminals, teleprinters, CRTs, hard-copy printers, keypunch, key-to-tape and key-to-disc entry devices, graphic plotters and remote batch entry/remote job entry (RBE/RJE) equipment.

Firms in this market are in the business of production, rental and sale of computers, networks and related equipment manufactured in Canada and elsewhere or purchased for resale.

A discussion of the electronic data processing market may also include computer services providers or service bureaus and software developers. Service bureaus provide such services as processing a client's requirements, input preparation, systems development, maintenance, software and consulting. In addition, because of the importance of software in driving the market for computers, a large number of software houses have been initiated in Canada and in the U.S. to cater to the demands of this new market.

Service bureaus and software companies will be discussed in the next section on the "Description of the Nature and Size of the Global Informatics Market". It should be cautioned that the delineation of these markets is very difficult to make because service bureaus also sell software packages and hardware suppliers offer software products.

Computer equipment vendors may be divided into mainframe manufacturers such as IBM, NCR, Sperry, Honeywell, Fujitsu; minicomputer manufacturers such as Digital Equipment Corporation, Data General, Four Phase, General Automation, AT&T; and personal computer or microcomputer manufacturers such as IBM and Apple. Although there are some basic architectural differences between mainframes and minis, this difference is receding and aside from cost and service considerations it is not apparent to many customers. Traditionally, mainframes have been large, batch oriented machines as opposed to minis which were built to be accessible in real-time on demand by the user, and were called on-line systems.

Worldwide computer sales between 1982 and 1985 are provided in the table below:¹

	1982 (\$ Billions U.S.) ¹	1983	1984	1985
Micro systems (Up to (\$12,000 per system)	11	20	30	33
Small Systems (\$12,000- 350,000 per system)	34	39	45	50
Large Systems (\$350,000 and above per system)	31	34	35	43

b. Office Equipment Market

The office equipment market consists of word processors, microcomputers, telecommunications equipment that provide integrated voice and data services, and private local area networks that link together various office equipments and photocopiers.

1. Financial Times, "The Computer Boom Sputters", Oct. 7, 1985. (Article data obtained from Evans Research).

The office equipment market is very difficult to quantify in terms of product range because of its overlapping with the computer and telecommunications markets and of the wide diversity of products that are marketed in this environment.

A recent study conducted for the federal Department of Communications² estimates that the world market grew from \$20 billion (U.S.) in 1980 to almost \$40 billion (U.S.) in 1985, with an average annual growth rate of over 14% during this period. In the word processing market alone Wang controlled 22% of the world word processing market in 1980, followed by AES/Lanier at approximately 12% and Xerox at nearly 10%.

A further development in this market is the appearance of integrated systems which under the control of a processor, link machines having different functions such as word processors, facsimile, electronic filing, terminals and mini or microcomputers by a coaxial cable based local area network of the bustype. Xerox's Ethernet, Wang's Wangnet local area networks serve these multiple purposes.

Office equipment sales in the United States from 1980 to 1985 are estimated as follows³:

<u>U.S.\$billion</u>	<u>1980</u>	<u>1985</u>	<u>Aver. Annual Growth Rate 1980-1985</u>
	\$	%	
Word Processing Equipment	3.5	29.5	5.8
		28.6	10.2%
Copying Equipment	4.7	39.2	8.7
		43.2	13.0%
Office Comm. Equipment	3.8	31.3	5.7
		28.2	8.6%
TOTAL	12.0	100	20.2
		100	10.9%

2. The World Telecommunications Market, "Appendix: Trends in the Office-of-the-Future", pp.113-122, (See reference no. 2).

3. See note 2 above.

For the Canadian market the breakdown of demand by product category should be similar to the U.S. The Canadian market may be roughly estimated to be 10 to 15% of the U.S. market. This was used in preparing the table below for the Canadian market which consolidates some of the data that was presented in the preceding tables.

<u>Can. \$ Million</u>	<u>1980</u>	<u>1985</u>
Word processing Equipment	\$ 350	\$ 580
Copying Equipment	\$ 470	\$ 870
Office Communications Equipment	\$ 380	\$ 570
Computer Systems	\$2,100	\$4,000
Microcomputers	N/A	\$600

c. The Role of Telecommunications

This section is intended to complement the previous two sections and to distinguish between the telecommunications market for data transmission, which has traditionally been a part that constitutes the informatics market, and voice, message and teletext communications, commonly provided by the carriers.

The trend in most organizations is to set up different networks for meeting the requirements of data, message and voice communications. IBM's network architecture, Systems Network Architecture (SNA) establishes the network for data processing as an entity with its own form and function. IBM's recent announcement of a local area network (LAN) addresses the requirements of the office automation market and is targeted for microcomputer communications and message or electronic mail communications. Voice and teletext services on the other hand have traditionally been provided by the common carriers on the public switched network.

As far as data communications are concerned, the carriers have also set up separate public switched networks which utilize packet switching technology dedicated to data communications alone. They are also differentiating the data communications market as a separate market from that of voice and message communications.

i) Data Communications

It seems that one of the major challenges facing many corporations is the integration of their telecommunications needs into one digital network which will provide cost efficiencies and enhanced network capabilities. A successful digital migration strategy is therefore under consideration in many large enterprises, and network managers are finding that they need strategic communications plans to adapt and manage new digital technologies such as Integrated Services Digital Network (ISDN).

For many organizations, this means merging the data processing and voice communications departments into a unified information resource management department.

ii) Message Transmission

Message communications relate to services that consist of the transmission of messages between terminals. Telex or TWX services are a type of message service.

By and large these services have been until now provided by the carriers who are lately marketing more sophisticated electronic mail services. However, with the introduction of the personal computer and word processing machines, as well as the availability of such text editing and electronic mail software packages as IBM's PROF, Digital's ALL-IN-ONE, alternative and to an extent complementary choices become available to computer users.

d) Personal Computers

The majority of personal computers or microcomputers are bought by small businesses, professionals and scientists as stand-alone systems for business applications. Such systems are used for carrying billing, accounting and inventory control. In addition, the availability of software packages for text editing and electronic mail enable users to use the system for word processing and communications.

Vendors would like to promote their products by providing better means and methods for doing office work. They increasingly offer complete solutions for office automation. It includes the use of personal computers or word processing systems for word processing, electronic mail, electronic filing, image processing (the ability to send a photocopied document to numerous locations) and graphics. Other support functions include access to databases, calendaring and spreadsheets. Spreadsheets enable the automated printing of reports with figures by aligning the columns and providing the means for the calculation of certain totals, percentages, etc.

Personal computers are also being purchased by individuals for their own personal use as a hobby. This consumer or hobby market, and the marketing of products in this market is quite different from the industrial market of professionals and businesses. Commodore 64 and the IBM PC Jr. are the leading personal computer products in the hobby or consumer market.

Also a significant market for the PC has become the child education market. Large volumes are being purchased by schools for educational purposes.

e) Factory Automation

The term CAD/CAM is currently very broadly defined and used. The CAD part includes computer aided mechanical and computer aided electronics or CAE. CAM or computer aided manufacturing has been slower to take hold.

The leaders in this market are ComputerVision of Bedford, Massachusetts, Calma a General Electric subsidiary located in Santa Clara, California, Integraph of Huntsville, Alabama and Applicom of Burlington, Massachusetts. IBM is also present in this market.

The long term tendency in automated manufacturing is to attempt to integrate all manufacturing functions, including design, production and business in a system which would control the entire process, from raw materials to finished products. This is called Computer Integrated Manufacturing (CIM).

Implementing CIM requires three types of integration: mechanical, electronic and information. CIM transforms today's factory from an assemblage of systems and subsystems operating more or less independently into a single entity. This new entity will comprise a hierarchy of computer hardwares, sensors, controllers and machine tools tied through a local area network. In this set-up product designing gets tied to manufacturing and distribution.

For example, at various Bell Laboratory locations, engineers design layouts for printed-wiring boards on a computer-assisted design system and check their efficacy on a computer-aided engineering system. The designs are then transmitted over communication lines to CAM systems which create detailed manufacturing specifications and instructions, numerical-control (n/c) files and routing details. A network of minicomputers linked to a multitude of n/c machines then start to manufacture the boards.

A typical firm can expect tangible benefits such as lower labour costs, higher speed, less scrap and rework and lower energy and raw-materials consumption. Intangible benefits are faster product introduction, higher product quality, improved management control, greater flexibility in meeting market demand and most important, optimized flows of information. On the negative side are a range of potential problems of adjustment, including: loss of management control over technology, autonomy, initiative and resourcefulness; a long learning curve; high capital investment, and disruption of traditional factory management methods.

The Canadian market for integrated manufacturing systems, computer assisted engineering, design and manufacturing systems and electronic office systems is estimated at \$200 million in 1985.

3. THE NATURE AND SIZE OF THE GLOBAL INFORMATICS MARKET

a) Overview¹

The informatics sector is closely linked to manufacturers of integrated circuits and to developers of specialized application software. The sector is essentially dominated by nine firms although it contains 106 firms under the definition of standard industry classification code (SIC) 318. There are considerably more firms if the related areas of software and telecommunications are considered.

The Canadian market for computer and office equipment was valued at \$4,619 million in 1984, up 28.7% from 1983. IBM accounted 40.2% of the market share in Canada. This is consistent with IBM's world market share of approximately 43%.

In addition to IBM, Digital Equipment Corporation, Control Data Corporation, Burroughs Memorex Inc., NCR Corporation, Sperry Univac Corporation and Honeywell together accounted for 85% of Canadian revenues in this sector. In revenue terms Canadian owned firms lagged way behind. AES Data was ninth in the Canadian market (1.9% of the market with sales of \$145 million) and GEAC Computers Ltd. 19th (0.9% of the market with sales of \$70 million).

In the 1984 Buyers' Intentions Survey of Financial Post Top Companies in Canada from Evans Research of Toronto, close to 700 companies were expected to acquire:

- i) 2,700 large central processor units (CPUs) ranging in price from \$35,000 to more than \$2 million each,
- ii) more than 3200 direct access storage devices (DASD) ranging in size from 11 megabytes to more than one gigabyte,
- iii) 43,600 terminals,
- iv) 10,200 printers and plotters,
- v) 9,600 microcomputers and 2,500 disk storage devices,

1. Electronics Industry Performance, Statistical Summary 1984, federal Department of Regional Industrial Expansion

- f) 2,400 word processing units with 4,500 screens,
- g) 180 multiplexors, 105 local area networks (LANs), 122 front-end processors for communications.

In general, it is expected that this market will continue to grow at a rate of 20% to 25% per annum to the end of the decade. Underlying this growth are developments in artificial intelligence, significant improvements in the cost and performance of semiconductors and the development of innovative software.

Most of the R&D carried on in this sector is between seven and eight percent of revenues. R&D strategy and location is centrally directed and carried out for the most part in the U.S. A significant exception is Control Data Ltd., which has undertaken all of the R&D associated with the Cyber 175 in Canada. Higher proportions of R&D, up to 15% of sales, are reached from time to time in the smaller companies. Product design and production technology originates in the U.S. which is pre-eminent in semiconductor design and software development (although Japan is making great strides in semi-conductor development and production). In 1983, for instance, the U.S. share had fallen to two-thirds of the world integrated circuit production while Japan's share had reached one-quarter and was expected to continue its steady increase.

The computer equipment industry is dominated by foreign controlled companies and foreign made products. The result is a severe trade deficit with very few Canadian companies attempting to compete on the international and domestic scene. In 1984 the trade deficit, calculated by subtracting from imports exports, exceeded \$3 billion. Canadian firms tend to seek a product niche, such as AES in stand-alone word processors or GEAC in library systems. There are no full line product manufacturers. The products manufactured in the main conform to standards set by other firms, notably IBM.

One notable exception is the very recent announcement by Motorola Information Systems of Brampton, Ontario of a new family of signal processors to address the high performance demands of real-time signal processing. The Motorola T-ASP 2000 Teamed Architecture Signal Processor boasts an impressive performance measure of 320 Million Floating Point operations per second, giving it comparable power to the largest supercomputer available for purchasing today. It is mainly targeted for use in process control applications and in the military.

One significant development is the recent emergence of AT&T in the informatics market. AT&T has sufficient resources, expertise and market presence to challenge IBM. It is expected to exploit its communications expertise to gain a strong presence in it. AT&T has begun its thrust by acquiring a substantial interest in Olivetti, a company with a strong office expertise. In turn, IBM has responded by acquiring ownership of ROLM Inc., a major manufacturer of telecommunications equipment.

b) Computer Equipment

i) Central Processing Units

Estimates¹ are that total unit sales of CPUs will increase by 12% in Canada in 1985.

Survey results show that most of the growth will take place at the low end of the market. In 1984, CPUs priced less than \$125,000 accounted for 45% of total unit installations. They will account for 59% in 1985.

Of interest is the strong unit growth 53.3% which is occurring in the low end of the market where CPUs cost \$75,000 or less. Evans researchers attribute this increase to the move by large corporations to distributed systems. One reason for this trend is the rapid expansion of point-of-sale systems and automatic teller machines.

1. Evans Research, as reported in Computer Data, March 1985.

ii) Disk Access Storage Devices

Over 50% of all disk storage devices acquired in 1984 and in 1985 are in the one gigabyte and over range. Large organizations seem to be replacing older, less cost-efficient devices with newer, higher capacity machines. However, Evans believes that an 11% decrease in the number of installations in 1985 is in large part due to decreased installations of high end CPUs.

The manufacturing and processing sectors followed by the retail and wholesale sectors were the largest installers of these units.

iii) Terminals

Synchronous terminals will account for 56% of all terminals installed in 1985. The total market for these terminals is expected to rise by 15%. Nearly half of these will be purchased by banks and financial institutions.

Asynchronous terminal population will drop by 23% in 1985 indicating a growing trend towards using synchronous terminals in most EDP organizations. Of these, the IBM 3270 terminals are the most popular, although the 3178s, which are lower priced, are gaining in popularity.

c) Office Equipment

The automated office market continues to be highly competitive and a potential growth area over the next decade because of the increasing expectation and acceptance for more rapid access to information and to its dissemination in most organizations.

Office automation operations consist of: the creation and distribution of documents; indexing and access to stored information; administrative support tools; computation and modelling techniques; presentation of information; control, dissemination and amendments of policy and procedure manuals; automated decision support systems.

International Data Corporation, a Toronto based research firm predicted that in the next five years, shipments of multifunction work stations will grow at an annual rate of 65%. However, concrete results have been very slow to materialize so far.

The market for multi-terminal word processors is growing much faster than stand-alone word processors. Wang, the industry leader in the multi-terminal market will take 51% of the market in 1985, leading IBM with 25%. In the stand-alone market IBM will be the leader with a 32% share, AES will have 17% and Micom 10%³. (All percentage figures refer to dollars).

This market is being attacked by the electronic typewriter with disk storage and screen options on the one hand and software packages for micros and minis on the other.

The word processing market is estimated to be between \$500 to \$700 million in Canada in 1985.

d) Personal Computers

In 1984 the total shipments for the Canadian personal computer market were 673,000 units. This figure represents total shipments for four application markets: business/professional, home/hobby, scientific and education. The value of shipments reached \$1 billion in 1984.⁴.

The report which was compiled by International Data Corporation Canada also forecasts that total shipments in 1985 will reach 1.723 million units with a dollar value of \$3 billion.

The Evans survey which deals with the business/professional market found that most organizations have at least one personal computer. These groups are using their micros for spreadsheet analysis, word processing, data base systems and graphics. In 1984, IBM was the dominant supplier with 58% of the units installed, followed by IBM compatibles at 8% and Apple at 7%. In 1985, IBM's share of the market is expected to decrease to 49%.

3. Evans Research Corp. as reported in Computer Data, March 1985.

4. Computer Data, "Micro Market Hits Billion \$", May 1985, p.17

e) Software Industry

Software may be defined as a set of programs, procedures, rules and routines used to instruct the computer in performing specific functions.

Software may be classified as systems software, applications software and systems development software.

Systems or operations software is that which directs the fundamental operation of the computer; it includes compilers such as Cobol, operating systems such as Unix, data base management systems and communications software.

Applications packages are programs designed to perform specific tasks such as order entry, word processing and electronic mail.

Systems development software combines both the development of customized systems software and applications software for certain specific customers by equipment vendors mostly and third party organizations. Because of its highly customized nature systems development software may be rarely made to apply to a broad range of customers

The growth of the informatics industry has resulted in an insatiable demand for systems analysts and programmers to exploit the full application potential of these devices.

For this reason, developments in software are important if there is to be a significant improvement in the production of the design and preparation of programs. One approach is to place more programming or program development into the hands of the end user.

Fourth generation software, examples of which are the various spreadsheet systems, is created for this purpose. A fourth generation software system is one which can be programmed without using the detailed step-by-step approach of traditional languages such as COBOL, FORTRAN and PL/I. This is the major challenge facing the software industry today.

In 1975 it was decided for example to finance the creation of a new language that would replace COBOL and FORTRAN. In 1983 ADA was developed by Honeywell Bull of France, and very soon a new version of COBOL is expected to be made available.

In addition, because software developed in-house by user groups is expensive and takes a considerable amount of time to produce, the use of off-the-shelf applications software packages is increasing while reliance on custom developed software is diminishing.

For many buyers of informatics hardware, the availability of useful software packages is of critical importance in influencing the decision of the selection of the hardware vendor. In recognition of this, hardware vendors have been making use of software as a marketing tool for their equipment. Recent mergers and acquisitions in the software industry in U.S.A. indicate that suppliers are attempting to consolidate their positions by purchasing software technology instead of reinventing it.

The computer hardware vendors and other equipment vendors supply almost half of the market. Also, most software suppliers operate service bureaus or are engaged in consulting services.

The software market may be further narrowed down to the following segments:

i) Packaged Software

They are sold "over the counter" complete with instructions for use and with the expectation that no further support is necessary. Most packages for microcomputers are sold in this way. Compiler, data base management programs fall also into this category.

ii) Custom Software

Many software companies have acquired considerable expertise in one or more specific system or application areas. The basic application package may be modified to suit the requirements of customers. Most application programs fall into this category (finance, production control etc.).

In the U.S. in 1980 there were 4,300 companies engaged in data services for the selling of software packages. However, only 147 of these had revenues exceeding \$10 million. IBM was on the top of this list with sales of \$595 million. In 1980, the packaged software market was valued at \$2.3 billion and the custom software market at \$2.1 billion.¹

The principal U.S. software companies outside the hardware supplies are, to name a few: Computer Sciences, Planning Research, Management Science America, CACI, American Management Systems.

The Canadian market for software was \$608 million in 1981, up from \$457 million in 1980. Sales of bundled software (that is included in the price of the hardware), and special purpose software such as video games and telecommunications software are not included.²

Currently, there are approximately 1400 firms who supply software to the Canadian market. In 1981 Evans Research had found that 53 key software suppliers account for nearly 75% of the total market. Of these 53 key suppliers 24 are hardware manufacturers. Their combined revenue accounted for 54% of the total market.

The major Canadian suppliers of software products are IBM Canada Ltd., Control Data Canada, Digital Equipment, Cullinane Canada, Systemhouse Limited, Cognos Corp., Synerlogic, Comshare, Office Smiths Inc., Logo etc.

In Canada, the relatively low cost of microcomputers has made it possible for numerous small software developers to enter this business. Many products lack essential ingredients such as thorough quality assurance, testing and lucid documentation. The products which fail unfortunately add chaos to the marketplace.

1. Zeman, Gotlieb, Russell etc., Les Strategies de Communications Dans Quatre Pays, Institut de Recherches Politiques, Quebec 1983.
2. Evans Research Corp., An Overview of the Canadian Software Industry, Toronto 1983.

The notable exception is Watcom Group of Waterloo, Ontario. Watcom develops and sells software packages for the computer science education market and for corporations. More recent products consist of software packages for data management and text processing.

Also marketed by Watcom are several products developed by the University of Waterloo. These include innovative networking solutions which connect micros in local configurations to mainframes and to other micros, for communication and sharing of resources such as files and printers.

Software distributed by Watcom is used worldwide with more than 3000 licenses for mainframes and minicomputers, and over 100,000 licenses for microcomputers. Watcom software is also marketed by IBM, Digital and Commodore and other major computer manufacturers.

Watcom has grown from a 3 employee company in 1981 to approximately 40 employees today. The company has been consistently profitable. Revenues in 1984 exceeded \$3 million.

f) Data Processing Services

The data processing service sector has traditionally been dominated by Canadian-owned companies. At present the industry is approximately 80 percent Canadian-owned. It is experiencing however, a high degree of turmoil, reflected by reduced growth in recent years.⁶

Hard hit by the recession and the pressures of lower computer prices, the computer services industry is undergoing evolution. Many data processing service bureaus have altered their product lines and services to accommodate the new realities of the market. Reduced hardware costs and the availability of improved software packages have placed companies, once dependent upon service

6. Globe and Mail, March 20, 1984. (Reported in the DOC study, reference No. 7), and the DOC study.

bureaus to handle their EDP activities, in a position where they now do their own data processing on their own terminals. Computing services at one time, primarily described processing time rented on mainframe computers. At present, service bureaus are becoming increasingly involved in network communications management and the selling of packaged services which combine computer time with customized software and specialized expertise.

General providers of data processing services are not doing as well as companies that provide specialty services. Specialty services have proven to be more profitable activities, both in Canada and the U.S. so that there has been a trend towards providing customized services to target groups, with an emphasis on total servicing and management.

Four of the top firms in Canada, Canada Systems Group, Crowntek, I.P. Sharp and Comshare are located in Ontario. All four have become involved in providing network and specialized services as opposed to their more traditional data processing services.

Revenues of Canada Systems Group, Crowntek, I.P. Sharp and Comshare in 1984 were \$132 million, \$131 million, \$49.5 million and \$9.2 million respectively.

The computer services industry as a whole had revenues of \$1.3 billion in 1984, and an average annual growth rate of 27 per cent since 1976.⁷

7. Computing Canada, "DRIE Study on Consulting Released", January 23, 1986, p.4.

4. COMPUTER-AIDED-DESIGN, COMPUTER-AIDED-MANUFACTURING AND COMPUTER-INTEGRATED-MANUFACTURING

a. Overview

This is a market still in the early stages of development, and therefore it is difficult to quantify its size and shape in the years to come. Statistics vary, disparities tend to be quite wide and there seems to be little information on the definition of equipment in the literature.

CAD or CAE systems automate design work, reduce design time, perform drafting and drafting revisions, store key specifications and, in some cases, even allow engineering departments to simulate the motion of a mechanism's parts. Most CAD/CAE systems employ special terminals equipped with high resolution screens capable of displaying intricate graphics, often in color. These terminals feature special devices, including plotters, light pens, "mouse" pointing devices and touch-sensitive pads, that allow an engineer or designer to converse with the system. While many CAD/CAE systems are based on large, expensive mainframe computers, the newer breed of CAD/CAE machines rely on or use microcomputers.

CAM systems take numerical data produced by CAD/CAE, and put it into a form that can be used by manufacturing departments. The newest CAD/CAE and CAM software developments enable numerical control (NC) instructions to be generated automatically from the CAD/CAE model without assistance from PC programmers knowledgeable in tool path generation procedures. IBM's CATIA is a three dimensional mechanical design system that generates NC instructions for use by an NC tool for the production of parts.

However, apart from such applications, the CAD/CAM or CAE/CAM capabilities of vendors have traditionally lagged behind those of CAD/CAE. It is obviously more difficult to automate the routing and assembling of parts on a shop floor than it is to automate design work. This is most unfortunate if it is considered that in most custom manufacturing operations roughly 95% of labour time is spent in this sort of activity.

IBM made its entry into the CAD/CAM or CAE/CAM market late by beginning to market software packages developed by others. CATIA, already mentioned, from Dassault Systems of France; CADAM, from Lockheed for obtaining drawings in magnetic form; CAEDS, from Structural Dynamics Research Corp. for linear analysis; and CBDS, developed by Bell Northern Inc. for circuit board design.

The CAD/CAM or CAE/CAM database becomes the key element in integrated manufacturing systems or CIM. New drawings, machine tool instructions and parts breakdown can be developed from CAD/CAM systems to form a CIM system. The computer can then create bills of materials, purchase orders, inventory reports and schedule production.

The value of the CIM market including CAD/CAM and CAE/CAM Systems in the U.S. is expected to reach \$100 billion by the end of the decade, quadrupling from its present level. IBM expects the CAD/CAM market in the U.S. to approach \$9 billion in 1989, up from a 1983 level of \$1.2 billion. The market for industrial products (process controllers, numerical controls, robots) is expected to hit \$12 billion in 1989. The Canadian market is expected to be about 10 to 15% of these figures which at best are estimates.¹

The market for designing electronic circuits, a \$260 million segment in 1984 was dominated by Valid Logic Systems, Daisy Systems and Mentor Graphics. This segment is projected to be worth \$2 billion (U.S.) in 1988.

At the leading edge of the nascent CIM industry is ComputerVision Corp. of Bedford, Massachusetts, with 1982 revenues of \$325 million, about 23% of the \$1.4 billion market. ComputerVision is the largest vendor of turnkey CAD/CAM Systems for product design and manufacturing. The company announced a three-tiered strategy to develop products, for: 1) the single user application environment incorporating intelligent workstations, standard operating systems and local area networking; 2) the multiuser, multiapplication environment; and 3) large scale mainframe users needing enhanced database management capabilities.

1. Datamation, "Manufacturing Technology" February 1984
Datamation, "Computer Integrated Manufacturing," March 1984
and Datamation "The State of CIM," December 1984.

ComputerVision has also entered into third party agreements with Sun Microsystems of Mountainview, California and IBM to implement this strategy. The company also acquired several software firms to provide software for IBM 4300 series computers.

ComputerVision supports the following activities.

1. Interactive NC machining. The programmer defines tool motion directly from the design data base, which in turn, is graphically displayed on a CRT while the tool path is created by interacting with the system. Specific code for various NC machines is generated by one of several hundreds post processors.
2. Off-line robotic programming. The design database includes models that are graphically simulated. At present, ComputerVision can supply databases for six existing industrial robots from three manufacturers: Cincinnati Milacron, Unimation and Automatix.
3. Classification of parts with similar characteristics. This allows the design information on parts with similar geometric features and manufacturing characteristics to be retrieved from the database for revision and customization.
4. Tooling and fixture design software. This allows the ComputerVision equipment to interface with coordinate measurement machines for part routing or set-up in machining operations.

Ultimately, CAD/CAM systems are integrated and linked to more traditional manufacturing processes such as Materials Requirements Planning and Production Scheduling and to corporate business functions such as financial, forecasting, etc.

CAD/CAM systems run on a minicomputer or supermini, such as Digital Equipment VAX-11/780, or a similarly powered machine from IBM, Data General, Hewlett-Packard and Prime. The typical cost of a single-user supermini CAD/CAM set-up is about \$300,000 (U.S.), while a typical four workstation system costs about \$500,000 (U.S.).

The fully or quasi-integrated manufacturing operation today might be using IBM equipment with IBM operating systems and data management for business functions; DEC VAX or CDC Cyber equipment for CAE; ComputerVision or Unigraphics for CAD/CAM; Data General or IBM equipment for shop data collection; DEC, Sentrol or Hewlitt-Packard equipment for test, quality and process control; Wang or AES for office automation.

According to a report¹ prepared for the Ministry of Industry, Trade and Technology of Ontario, the use of flexible automation equipment in Canada is still in its infancy. Some of the CAD/CAM manufacturers maintain skeleton branch offices in Canada which are serviced mainly from the U.S.

Sun Microsystems, a recent entrant to the Canadian market is currently shipping \$200,000 worth of equipment a month. There are about 10 employees now. Sun Microsystems had revenues of \$70 million in 1984. Western Canada is handled out of the U.S., and half of the systems shipped to Canada represent sales to Western Canada.

Integraph, an established company, had revenues of \$25 million in 1984 in Canada, \$400 million for the entire corporation. The company is based in Calgary and has nine offices employing 150 people. The company sells systems based on Digital's VAX family of minicomputers. Its installed base in Canada is approximately 120 systems, supporting 650 workstations.

b. Statistics of Major Manufacturers

Market sales and market shares of major U.S. based vendors were as follows:

Company	1984 Sales (\$Mil)	Market Share (%)
ComputerVision	566	20
IBM	504	18
Integraph	468	17
Calma	250	33
McDonnell Douglas Automation	104	4
Applicom	102	4
Control Data	90	3
Mentor	80	3
Daisy	80	3
Auto-trol	70	3

1. Ministry of Industry, Trade and Technology. Flexible Automation Equipment, Nov. 1985.

A census of CAD/CAM equipment and robots in use in Canadian organizations in 1985 is provided in the May 1985 issue of Canadian Machines and Metalworking magazine published by Maclean Hunter.

5. STATISTICS ON CANADIAN COMPUTER AND OFFICE EQUIPMENT MARKETS

The statistics covered in this section pertain to SIC code number 318, Office and Store Machinery Manufacturers (See Appendix).¹

a) Principal Statistics

	<u>1980</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>
Establishments	75	71	92	106	n/a
Employment	13,540	16,161	16,930	15,883	n/a
Shipments (\$ mil)	889	1,147	1,180	1,283	1,558
Investment (\$ mil)	138.9	213.7	212.6	282.4	315.0

b) Trade Statistics

	<u>1980</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>
Domestic Exports (\$ mil)	739	874	927	1,068	1,377
Re-Exports (\$ mil)	187	237	260	310	428
Domestic Shipments(\$ mil)	150	273	253	215	181
Imports (\$ mil)	2,138	2,883	3,144	3,375	4,866
Canadian Market (\$ mil)	2,101	2,919	3,137	3,590	4,619
Domestic Exports as % of shipments	83.1	76.2	78.6	83.2	88.4
Imports as % of domestic market	101.8	98.8	100.2	94.0	105.3

c) Source of Imports

- U.S.A.	-	\$4,220 Mn.
- Japan	-	\$ 315 Mn.
- EEC	-	\$ 172 Mn.
- Taiwan	-	\$ 47 Mn.

d) Source of Exports

- U.S.A.	-	\$1,420 Mn.
- EEC	-	\$ 280 Mn.

e) Regional Distribution - Average over the period 1980-1982

		<u>Atlantic</u>	<u>Quebec</u>	<u>Ontario</u>	<u>Prairies</u>	<u>B.C.</u>
Establishments -						
% of total	n/a	20.0	66.3	4.1	9.6	
Employment -						
% of total	1.8	28.6	60.5	9.1	9.1	
Shipments -						
% of total	n/a	28.8	69.5	1.7	1.7	

f) Major Firms

<u>Name</u>	<u>Ownership</u>	<u>Location of Major Plants</u>	<u>Concentration (% of domestic market)</u>
IBM Canada Ltd.	U.S.	Markham, Bromont	40.2
Digital Eqt. of Canada Ltd.	U.S.	Kanata	5.5
Control Data Canada Ltd.	U.S.	Toronto	3.4
Burroughs Memorex Inc.	U.S.	Toronto	3.1
NCR Canada Ltd.	U.S.	Toronto	2.8

	<u>1984 Sales (\$Mil.)</u>	<u>1984 Profit (\$Mil.)</u>
IBM Canada Ltd.	2487.2	247.8
Digital Eqt. of Canada Ltd.	419.7	25.1
Control Data Canada Ltd.	240.7	21.2

g) Federal and Provincial Government Programs

<u>Program</u>	<u>Amount</u>	<u>Purpose</u>
Ontario Educational Computer Development	\$5.0 Mn.	Develop an "Official" Educational Computer
Quebec Educational Computer Development	\$5.0 Mn.	Develop an "official" Educational Computer
Federal Task Force of Informatics Review	-	Assess impact of Informatics
Office Communications Systems Development Field Trials	-	Test office, and automation systems

h) Analysis of Growth and Trends of Computer Equipment 1980-84

Area of Comparison	Computer Class								Annual Growth %	
		1980	1981	1982	1983	1984	1985	1984	1985	
Number of Computers	Large	439	478	511	533	555	550	4.1	6.0	
	Medium	2,930	3,445	3,902	4,119	4,597	4,100	11.6	11.9	
	Small	17,173	18,692	23,483	25,470	27,844	35,000	9.3	12.8	
	TOTAL	20,542	22,615	27,896	30,122	32,996	39,650	9.5		
Annual Rental Value (\$Mil.)	Large	577	650	739	830	898	765	8.1	11.7	
	Medium	541	636	720	758	831	740	9.7	11.3	
	Small	507	568	678	731	799	985	9.3	12.0	
	TOTAL	1,626	1,855	2,138	2,319	2,528	2,490	9.0		

Source: CIPS Review March/April 1985 p.10. Large computers are classified as those having a monthly rental value above \$50,000, medium computers between \$5,000 and \$49,999 and small computers between \$1,000 and \$4,999. Figures represent the value of the complete systems.

i) Computer installations in Canada-
by Manufacturer within rental class
December 31, 1984

Classified by Supplier and Monthly Rental

	\$1,000 to \$1,999	\$2,000 to \$4,999	\$5,000 to \$9,999	\$10,000 to \$19,999	\$20,000 to \$49,999	\$50,000 to \$99,999	\$100,000 and Over	Other and Not Identified	TOTAL
Burroughs Business Machines	116	70	47	35	21	9	1	2	301
Digital Equipment of Canada Data	1,296	836	609	314	146	23	7	15	3,246
General Corporation Hewlett-Packard Ltd.	348	190	82	37	3	3	3	1	667
Honeywell Information Systems	205	257	274	68	68	2	1	15	890
IBM Canada Ltd.	164	212	136	49	64	31	6	1	663
MAI Canada Ltd.	747	832	519	371	330	148	158	13	3,118
NCR Canada Ltd.	127	172	34	5	—	—	—	3	341
Northern Telecom Ltd.	276	164	39	16	19	1	—	5	520
Sperry Inc.	151	113	1	3	—	—	—	1	269
Other	57	90	77	75	71	27	10	2	409
TOTAL	4,883	3,925	2,128	1,156	811	307	214	156	13,607

Source: CIPS Review, March/April 1985, p.8.
(Figures represent the value of the complete systems).

j) The Top 20 Companies in the Canadian Computer Industry (1983)

Company Name	Total Revenues 1983 (\$ Millions)	Total EDP Revenues 1983 (\$ Millions)	Source Code
1. IBM Canada	2,462.0	2,164.0	C
2. Digital Equipment of Canada	308.5	308.5	A
3. Control Data Canada	240.7	240.7	A
4. Philips Information Systems	187.5	187.5	B
5. NCR Canada	199.2	173.3	C
6. Sperry	325.3	144.0	C
7. Burroughs Canada	154.6	142.6	B
8. Canada Systems Group	140.1	140.1	A
9. AES Data	134.0	134.0	A
10. Hewlett-Packard (Canada)	194.9	112.0	C
11. Honeywell	334.0	112.0	C
12. Commodore Business Machines	n/a	110.0	C
13. Amdahl	104.2	104.2	B
14. Datacrown	84.3	84.3	A
15. Radio Shack	235.4	74.2	C
16. Wang Canada	65.9	65.9	B
17. British Columbia Systems	65.0	65.0	C
18. Memorex Canada	62.9	62.9	B
19. GEAC Computer	62.4	62.4	C
20. Apple Canada	59.8	59.8	C

Source: Computer Data, September 1984, p.2. (Evans Research Report). (Source Code: A-published by Company, B-Confirmed by Company officer, C-estimated by Evans Research).

k) Canadian Microcomputer Forecasts
(Number of Units)

Year	Small & Med. Bus.	Large Bus. & Gov't.	Education	Total	Annual Growth (%)
1982	74,971	47,599	20,250	142,820	76.9
1983	140,120	69,971	42,500	252,591	62.9
1984	243,809	93,260	74,375	411,444	48.0
1985	371,966	117,781	119,000	608,747	38.9
1986	520,203	146,338	179,244	845,785	33.6
1987	688,400	190,165	251,186	1,129,751	29.2
1988	877,204	244,873	337,926	1,460,003	23.5
1989	1,052,237	313,347	437,551	1,803,135	

Source: Evans Research Corp. (Dec. 84) as reported in the CIPS Review,
March/April, p. 10.

6. USER EXPERIENCES: SOME EXAMPLES

In this section the application of computers and office automation equipment in a user environment will be described. The application of computers for improving the interaction between insurance brokers and insurers, and the use of automation in banking will be discussed. This will be followed by reviewing the state of office automation at DEC Canada, Telecom Canada and IBM Canada.

a) Computer Applications

In Canada, there are more than 600 insurance agencies/brokers with IBM PCs installed. Generally, these systems have been cost justified for accurate and timely accounts receivable, accounts payable applications and management reporting. However, increasingly these systems will be utilized for sending information from a broker to the large main frame of the insurer.¹

The Canadian Centre for the Study of Insurance Operations (CSIO) is working diligently to define and refine acceptable standards that will dictate the specific way to send information from a broker to an insurer. The main drawback with the current method of interface is that, as a broker handles more than one insurer, there are multiple systems and codes to learn and probably different terminals on which to work.

The next generation of systems promise to provide improvements through the implementation of distributed software and common interface standards. These software systems, currently available from Policy Management Systems Ltd., operate on the broker's hardware providing insurance processing functions, and also have the ability to gather data and transmit it to the insurer.

1. Canadian Insurance/Agent & Broker, "Interface: No Need to Wait", September 1985, pp. 14-16.

In Canada, banks have been automating for 30 years to better deal with traditional needs and to make new services possible. The first step in automation was the introduction of magnetic ink character recognition on checks. By the introduction of automated teller machines (ATM), customers became their own tellers for transactions conducted through ATMs. Bankers can have more control over their businesses with so many transactions flowing through computers. Computers have also allowed the development of daily interest savings accounts and pre-authorized payments to and from customers' accounts. Most major banks are offering business customers the ability to conduct many transactions directly from their offices. However, home banking will not become a reality until consumers desire the service enough to pay for it. Debit cards and point-of-sale services are being tested in the U.S. and Canada. Even traditional credit cards can be more tightly controlled by use of computers to check lost and stolen cards.

2. Office Automation

Digital Equipment Corporation of Canada has 2,100 employees, 1,500 of which are involved in office type work; 700 of these at the head office in Kanata, Ontario near Ottawa, and another 800 in field offices.

There are two 2060 DEC mainframes, 25 VAX-11/780s and 750s and 40 PDP-11 minicomputers, 450 microcomputers, 950 dump terminals and a variety of letter quality printers and dot matrix printers. Practically every white-collar worker has a micro or terminal.

Word processing at DEC is carried out by using DEC's own microcomputers and All-In-One office automation software program. Electronic mail is now being implemented across Canada.

All computer equipped sites are front-ended by Gandalf data communications switches. There is also an extensive voice network, and most sites have SL-1 PBXs from Northern Telecom.

Telecom Canada is made up of Canada's nine major telecommunications carriers and Telesat. There are 650 employees in 40 districts. The company has been automating for several years.

There are 114 terminals spread through the organization so that everyone has access to one. A breakdown of these 114 is as follows:

- . 48 are terminals for general use;
- . two personal computers are dedicated to the information centre and iNET applications;
- . 21 terminals in the word processing centre, all on one system with a variety of printers;
- . 5 stand-alone word processing systems;
- . 5 portable terminals for out-of-office use;
- . 2 displayphones;
- . 8 RJE terminals;
- . 7 3270 terminals; and
- . 2 TWX terminals and a facsimile unit.

Everyone can access the Envoy 100 electronic messaging service.

IBM Canada has a total workforce of approximately 11,000 people, 7,000 of which are involved in the traditional office environment.

Since 1982 the company has lowered its ratio of terminals/micros to workers from more than 4 to 1 to almost 1 to 1. For more than a decade the company has been working on improving productivity in the office. PROFs is one of the three tools available to employees. It provides text editing, calendars, electronic mail, phone directories and automatic reminders. The Audio Distribution System (ADS) is another tool available. It is a voice store and forward message system. The third tool is Stairs, a text based system for capturing all marketing manuals and new product announcements on computer for accessing by field sales personnel.

7. VERY LARGE SCALE SYSTEM INTEGRATION

a) Overview

Because of developments in telecommunications, which have resulted from the awareness shown by both computer equipment makers and telecommunications equipment manufacturers and carriers, in the integration of data processing systems through a flexible communications medium, the methods of the connection of systems to networks have instigated intensive investigation. This is also referred to as the convergence of computers and communications.

What is desired is access through a single query language and database scheme to data in pre-existing, heterogeneous, distributed applications, existing on different computer hardwares linked through an efficient communications network. A possible application example for such a distributed data base might be the updating of a passbook from any banking terminal, regardless of its location. The transaction message would first be directed to the connecting computer site, from which it would then be transmitted automatically to the appropriate computer in the appropriate location containing the financial savings information of the customer, for processing and eventual passbook updating.

Although this example illustrates the application of the distributed data base concept in a well defined environment of similar systems belonging to the same vendor and user, the concept can be extended to different systems that receive and send messages among themselves. For the latter to be made applicable, not only is the development of integrating software necessary, but its standardization becomes mandatory as well.

In addition, the development of independent communications networks which can process transactions at a faster rate becomes desirable, if fast response at the users level is to be expected. When dissimilar systems are used, the data base may be distributed widely and its distribution may not necessarily be known to the initiating system which interacts directly with the user. The network would then be the processor for such a transaction, and would provide a directory, and therefore a path to the location of the sought data base in order to respond satisfactorily to

such a request. For example, the search for a book which is not available in a library may be processed by the telecommunications network who would ask a number of libraries' computer systems, in successive order, to search for the book until it is located, and the pertinent information provided back to the enquirer at the terminal.

The problem of building such a software system is so enormous that no one has been able to tackle the whole thing entirely. The problem has resolved itself into four separate but highly related subsets of technology: 1) user interface technology, 2) distributed heterogeneous data management technology, 3) network transaction management technology, and 4) interprocessor communication technology.

Reference models and standards evolve from projects that invent and test possible solutions. In the U.S., four public projects are attempting to expand our knowledge and technology for dealing with distributed, heterogeneous data management. These are very briefly described below.

Multibase

Multibase is a prototype software system that provides a uniform, integrated interface, which allows the user to reference data in distributed, preexisting, heterogeneous databases with one query language over one database description. Practical applications of the prototype are being made at General Dynamics (i.e., the CAD/CAM Database Management System) and at Rockwell International. The project is being conducted by Computer Corp. of America (CCA), Cambridge, Mass., and is jointly supported by ARPA and the U.S. Navy.

Integrated Information Support System (IISS)

IISS is a software system that achieves control of and access to information in preexisting, distributed, heterogeneous databases to allow data shareability and to provide a means for improving data quality and data timeliness. Practical applications of this technology are being made by Boeing and McAir. IISS research is being conducted by Boeing, DACOM, SDRC, and CDC under contract with the U.S. Air Force at Wright-Patterson Air Force Base in Dayton, Ohio.

Integrated Design Support (IDS) System

The IDS project is chartered to assemble various off-the-shelf tools and to add technology as required to support the management and control, update, and retrieval of existing and future technical data for the B-1B aircraft. These technical data are distributed in heterogeneous databases. The technical project is being conducted by Rockwell, DACOM, SDRC, and CCA for the USAF at the Wright-Patterson base in Dayton.

Integrated Manufacturing Distributed Database Administration System (IMDAS)

IMDAS is a prototype software system that provides update and retrieval services over preexisting, distributed, heterogeneous files and databases. The project is being sponsored as part of the National Bureau of Standards' Advanced Manufacturing Research Facility and is being conducted by NBS (Gaithersburg, Md.) and the University of Florida.

b) IBM's System Network Architecture (SNA)

The most commonly implemented computer standard for computer communications today is IBM's Systems Network Architecture (SNA). Despite their widespread acceptance SNA networks have some shortcomings:¹ incompatible session layers (a session layer coordinates interaction between end-application processes), limited connectivity

between workstations, lack of local area network or alternative transmission facility support, too much reliance upon mainframe control and cumbersome definitions of network resources and configurations.

Evidently aware of the shortcomings IBM is now in the process of implementing some sweeping SNA product changes, and has developed new extensions to the architecture of SNA itself. Unfortunately, what seems to be lacking is a discussion of the ease of implementing distributed data bases within an SNA system, especially the new SNA system extended and planned.

1. Datamation, "Coming: A New SNA", November 1985, p. 102-112.

It is expected that such changes as well as others will be forthcoming from IBM. The recent policy announcement by President John Akers in a Business Week article, to the fact that IBM intends to make a major presence in the telecommunications market, pertains to this.

c) Integration Technology for Factory Automation

An industry generated factory automation protocol, (MAP) or manufacturing automation protocol, which is very fast becoming an international standard, will provide for growth in the areas of computers and computer communications, and improve the productivity of manufacturing operations in North America and the world.

Already quite a few companies have embraced MAP: General Motors, McDonnell Douglas, Eastman Kodak, Proctor Gamble, Ford to name a few. With General Motors alone committed to spending some \$40 billion over the next four years on plants and equipment, this is a market which by itself may fuel economic growth.

Essentially, MAP is a seven-layer, broadband, token bus-based communications system which breaks down network communications into logical sections that can be dealt with by individual vendors. This means that computers and computer controlled devices of different vendors may be made to communicate on the factory floor.

The MAP model evolved in 1980 when GM was looking for a way to obtain interface between different programmed processors. The company currently uses more than 40,000 computer-programmed devices in its plants, a number forecasted to climb to 200,000 by 1990.

Companies which have pledged cooperation with the MAP initiative already number fifty and include Concord Data Systems, Allen Bradley, Intel, Industrial Networking Inc., Hewlett-Packard, Digital, Motorola, General Electric, IBM etc.

According to our own Ontario Centre for Advanced Manufacturing (OCAM) Canadian awareness of MAP is below that in the U.S. Only one company, Northern Telecom is working on the interface of a MAP protocol to the X.25 communications protocol which is that which is used in packet switching.

APPENDIX

SIC 318. OFFICE AND STORE MACHINERY MANUFACTURERS

Accounting machines, mfg.
Adding machines, mfg.
Business machines, mfg.
Cancelling machinery, mfg.
Card sorting and tabulating machines, mfg.
Cash registers, mfg.
Cheque-writing machines, mfg.
Coin counters and changers, mfg.
Coin-wrapping machines, mfg.
Control devices, computer, electronic, mfg.
Credit account registers, mfg.
Dating devices, mfg.
Dictating machines, mfg.
Duplicating machines, mfg.
Electronic computers and data processors, mfg.
Envelope filling machines, mfg.
Envelope sealers, mfg.
Gummed tape moisteners, mfg.
Letter folding machines, mfg.
Mailing machines, mfg.
Manifolding machines, mfg.
Mechanical calculating machines, mfg.
Mimeographing machines, mfg.
Multiplying machines, mfg.
Office and store machinery, mfg.
Perforators, protection devices, mfg.
Post office cancelling machines, mfg.
Postage meters, mfg.
Presses, seal, mfg.
Scales and balances, mfg.
Sealers, hand, gummed tape, mfg.
Stencil machines, mfg.
Tape dispensing machines, mfg.
Ticket counting machines, mfg.
Typewriters and prts, mfg.
Vending machines, mfg.
Weighing machines, mfg.

Ref: 1970 Standard Industry Classification from Statistics Canada.

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